Product User Manual

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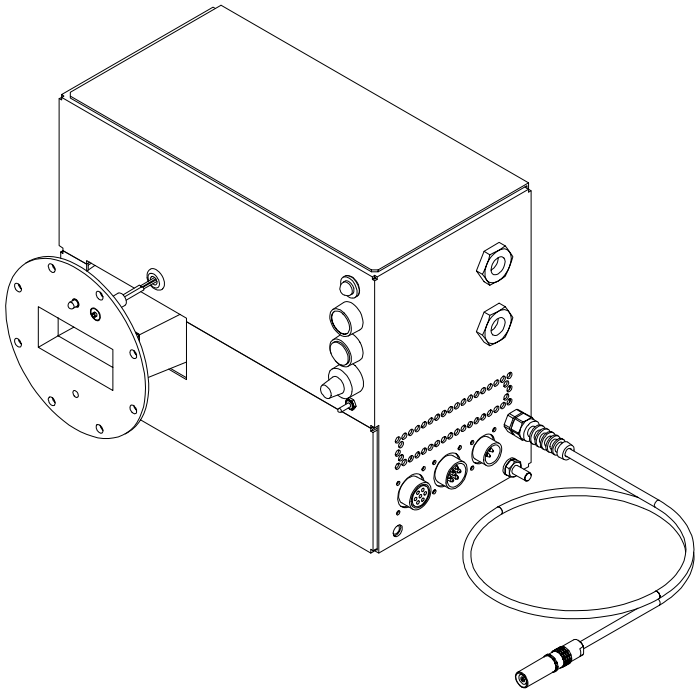
Model GA4002
1.8kW Magnetron Head



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Products manufactured and sold by Gerling Applied Engineering, Inc. ("GAE") are warranted to be free of defects in materials and workmanship under normal use and service for a period of twelve (12) months from the date of original shipment. GAE's obligation under this warranty is limited to repairing or replacing, at GAE's option, all non-consumable component parts. Consumable parts are specifically excluded from this warranty and may include, but are not be limited to, magnetrons, fuses, lamps, seals, o-rings, v-belts, and fluids. All warranty repairs are to be done at GAE's facility or as otherwise authorized by GAE. All shipping charges for warranty repair or replacement are the purchaser's responsibility unless otherwise agreed to by GAE.

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DOCUMENT CONVENTIONS

NOTE: *Means the reader should take note. Notes contain helpful information, suggestions, or references to other sections, chapters, or documents.*

CAUTION: *Means the reader should be careful. You are doing something that might result in equipment damage or loss of data.*

WARNING: *Means danger. A situation exists that could cause bodily injury or death. All personnel must be aware of the hazards involved with high voltage electrical circuitry and high power microwave devices.*

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WARNING

All magnetron heads manufactured by GAE, Inc. are capable of producing a microwave field that is potentially hazardous to operating personnel. They must never be connected or operated in a manner that allows a field in excess of 10 milliwatts per square centimeter to be generated in an area accessible to operating personnel. Contact GAE, Inc. for technical support prior to installation and/or operation of these units if there is any question or concern about microwave leakage.

All waveguide flange and electrical cable connections throughout the system must be secure prior to operation. Never operate the microwave generator without a properly rated absorbing load attached. To ensure safe operation and prevent microwave leakage, the equipment must be periodically inspected and maintained as required or recommended.

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EQUIPMENT DESCRIPTION

The GA4002 Magnetron Head is designed to deliver nominally 1.8kW of microwave power when used with the model SM745 Switching Power Supply manufactured by Alter. A complete system requires only the GA4002, the SM745 and its mating Line Power/Control cable set (also available separately from Alter), thus greatly simplifying the task of system design and integration. All mating connectors are provided.

All controls necessary for operation of the SM745 power supply as well as connections for remote control are provided in the GA4002. The magnetron filament transformer is also packaged inside the unit for added convenience.

The complete unit is replaceable by simply disconnecting the waveguide flange and electrical connectors. Removal and replacement of the internal magnetron can be done in less than ten minutes using standard tools. The magnetron is water-cooled for enhanced life under high power operation. Magnetrons compatible for use in the GA4002 are available from a variety of suppliers.

A powder-coated steel enclosure provides rugged durability while multiple safety interlocks meet compliance requirements. Convenient mounting holes and brackets facilitate bench-top use or integration into process systems. Optional features include alternate flange configurations, arc detection and custom (private) labeling and colors.

Model GA4002 features the popular WR284 Q-D (quick-disconnect) round flange that uses the convenient single screw clamp (GAE model GA8401) for waveguide connections.

General Specifications

Output Power (max)	1.8 kW
Magnetron	Water-cooled Hitachi 2M130 (or equivalent)
Output Waveguide	WR284
Output Flange	UG584/U
Frequency	2450 MHz +/- 30 MHz
Cooling	0.5 gpm water @ 35 °C max. inlet temp (dew point min. inlet temp), 70 psi max. inlet pressure
Controls	Mw Start (pushbutton) Mw Stop (pushbutton) Mw Power Adjust (10-turn Dial)

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	HV On (Red LED) Power Adjust Selector (toggle switch)
Interlocks	Waveguide flange; Access cover; Magnetron over-temperature

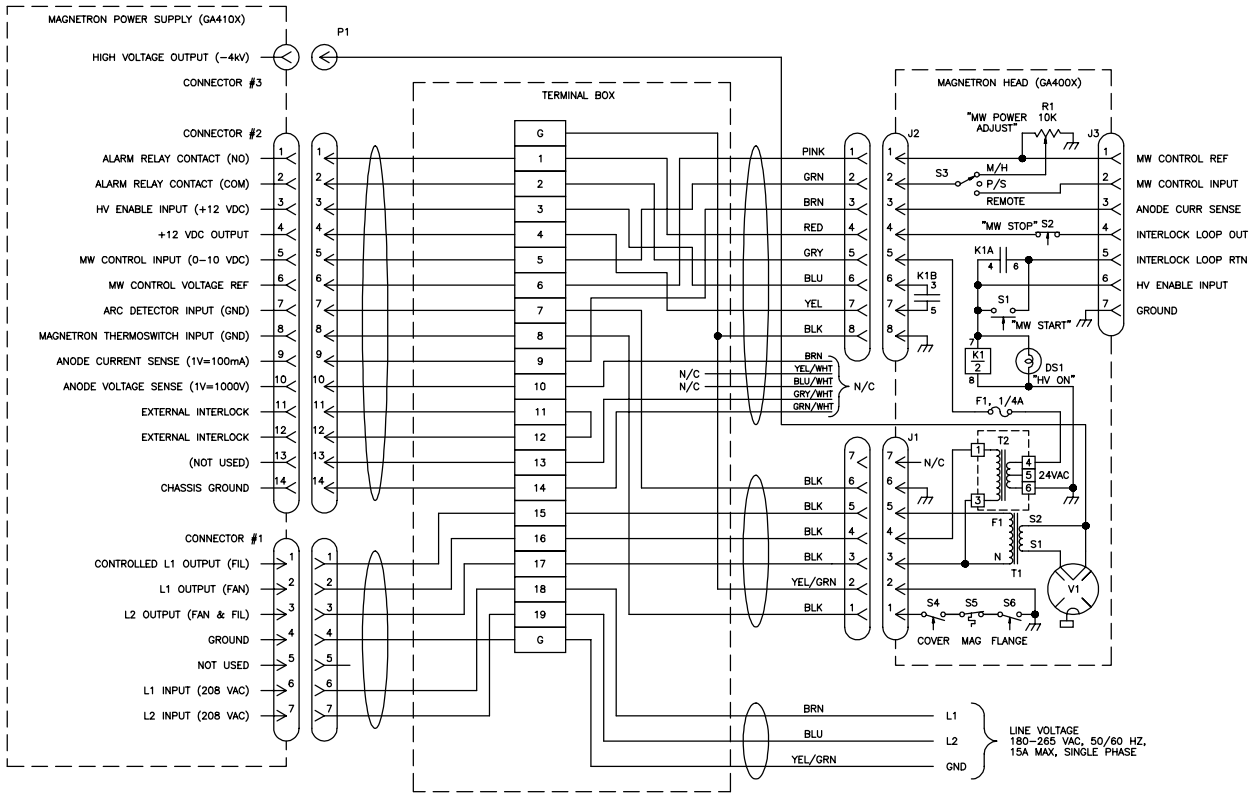
Mating Connectors (supplied with GA4002)

High Voltage	Lemo series 1Y
Fan & Filament Power	Shell: AMP # 206060-1 Contact: AMP # 66105-4
Power Supply Control	Shell: AMP # 211399-1 Contact: AMP # 66105-4
Remote Control	Shell: AMP # 211400-1 Contact: AMP # 66103-4

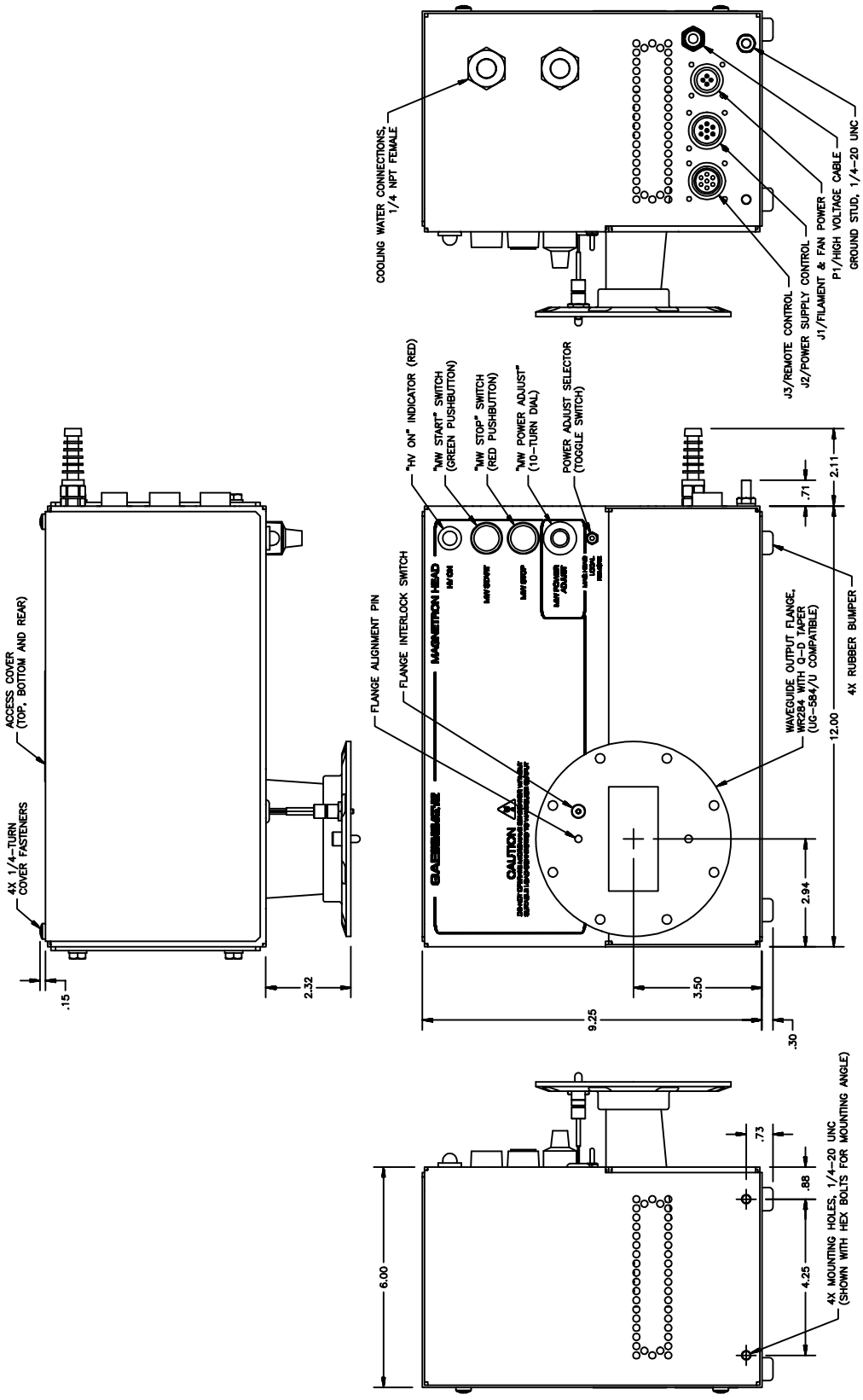
Recommended Alter Components (available separately)

Switching Power Supply	SM745F.003
Cable Set	44/1384745

Schematic Diagram



Outline Drawing



INSTALLATION

Preliminary Inspection

Upon arrival at the installation site the GA4002 magnetron head should be thoroughly inspected for damage or wear caused during shipping. Any visible damage to the packaging material or the magnetron head itself should be noted and reported immediately to the shipping company in accordance with standard claims procedures. The following components are included:

a) GA4002 Magnetron Head

b) Mating connector set (filament & fan power, power supply control and remote control)

c) Product User Manual

Waveguide Configuration

The GA4002 magnetron head can be connected to and used with any common waveguide component having a compatible flange (see below). Mounting can be in any convenient position and orientation. Ideally, the magnetron head should be connected directly to an isolator (or 3-port circulator and dummy load) to ensure adequate protection of the magnetron from reverse power. Figure 1 illustrates a typical waveguide configuration.

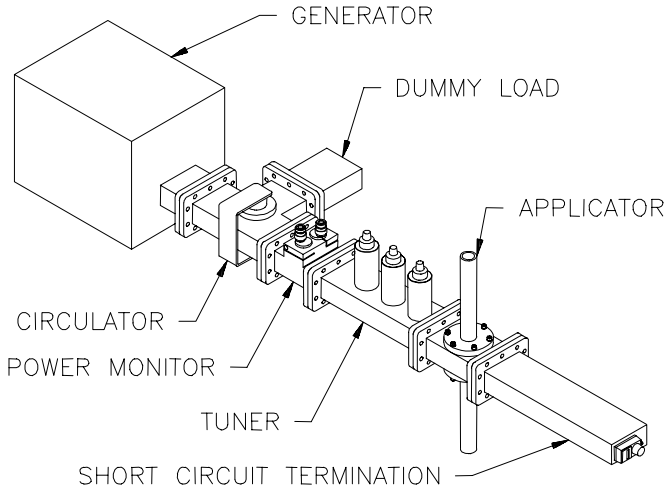


Figure 1 – Typical waveguide configuration for process heating.

Flange Connections

The waveguide flange of the magnetron head must be properly connected to another waveguide component or series of components that provide an adequate load for the microwave power being generated. Bolts and nuts must be installed at all flange bolt holes prior to operation. Model GA4002 is configured

with a flange designed for used with the GA8401 Quick-Release clamp when connected to another similarly designed flange. This flange can also be connected to any other standard WR284 round flange (UG-584/U) using suitable fastener hardware.

Flange Alignment Pins

Each waveguide flange connection that uses a quick-release clamp requires two alignment pins for proper alignment of the adjacent waveguide sections. All GAE waveguide components include one alignment pin for each flange designed for use with quick-release clamps. Alignment pins can be installed into either of two threaded holes centered above and below the waveguide broadwalls. For obvious reasons, the pins must not be installed such that they are opposite each other on mating flanges.

Microwave Leakage – Regulatory limits for microwave leakage relate to standards for human safety and interference with other electronic devices. Standards for human safety as adopted by OSHA, the International Electrotechnical Commission (IEC) and other regulatory agencies limit leakage to 5 mW/cm^2 measured at 5 cm from the leakage source under normal operating conditions, and 10 mW/cm^2 at 5 cm from the source under abnormal operating conditions. The U.S. Federal Communications Commission (FCC) has established regulations limiting the emission of energy at frequencies outside the ISM bands. All GAE waveguide components meets these requirements when properly connected to another waveguide component.

Water Flow Requirements

A source of water must be connected to the GA4002 that provides an adequate rate of flow. The nominal water flow rate is 1.0 gpm. However, the flow rate must be maintained such that the outlet water temperature does not exceed 150 °F. The minimum allowable flow rate depends on the level of incident microwave power and the inlet water temperature.

CAUTION: *Failure to provide an adequate rate of water flow can result in severe damage to the GA4002. It is strongly recommended that an interlock device such as an in-line water flow switch be used to prevent operation of the microwave generator in the event of inadequate or loss of water flow.*

CAUTION: *The <u>minimum</u> inlet temperature of the cooling water must be above the ambient dew point temperature. Allowing the cooling water inlet temperature to drop below the ambient dew point can allow moisture condensation inside the microwave*

generator and/or waveguide circulator and cause equipment damage.

Water Fitting Connections

Standard 1/4 NPT female fittings are provided at the side of the GA4002 enclosure. The source of water can be connected to either fitting. It is recommended that a thread sealant such as Teflon pipe thread tape be used to ensure a leak-free connection. Care should be taken to prevent debris from falling into the fitting holes.

Since there may be other waveguide components in the system that require cooling water, it may be possible to run all of the water cooling connections in series. In this case, it is recommended that the magnetron head be connected last in the series. Caution should also be exercised to ensure that the resulting water flow rate is adequate for all components.

Power Supply Connections

With the exception of remote control, all electrical power required for operation of the magnetron head is provided by the magnetron power supply. All connectors are located at one side of the magnetron head. The following describes the pinouts for each connector:

J1 – Filament and Fan Power

Pin 1 – Magnetron head interlock return (ground)
This signal is grounded when all three internal magnetron head interlocks are satisfied. Microwave power cannot be generated if any of these interlocks are open. Microwave power will cease to be generated if an interlock opens during operation.

Pin 2 – Chassis ground

Pin 3 – L2 input for filament and fan power (208 VAC)
This signal is the L2 phase of the power line supplying power to the filament and fan.

Pin 4 – L1 input for fan power (208 VAC)
This signal is the *uncontrolled* L1 phase of the power line and supplies power to the fan.

Pin 5 – L1 input for filament power (controlled 208 VAC)
This signal is the *controlled* L1 phase of the power line and supplies variable power to the filament transformer.

Pin 6 – Ground (used for arc detector signal output)
This signal is intended for future use by the output of an arc

detector circuit. It must be ground for operation of the magnetron head and generation of microwave power.

Pin 7 – No connection

J2 – Power Supply Control

Pin 1 – Microwave control voltage reference (+10 VDC)
This is a DC voltage supplied to the microwave power control potentiometer located in the magnetron head. It can also be used as a voltage reference by an external power control potentiometer.

Pin 2 – Microwave control voltage output (0-10 VDC)
This is an analog DC voltage proportional to the setting of the microwave control potentiometer located either inside the magnetron head (R1) or remotely.

Pin 3 – Anode current sense input (1 V = 200 mA)
This signal is generated by the magnetron power supply and is proportional to the magnetron anode current. It is proportional to magnetron output power and thus can used as an indication of microwave power generated by the magnetron head.

Pin 4 – Power supply interlock loop return (24 VAC)
This signal is present when all internal interlocks of the magnetron power supply are satisfied. This signal must be present for operation of the magnetron head and microwave power generation. Microwave power will cease to be generated if a power supply interlock opens during operation.

Pin 5 – Power supply interlock loop output (24 VAC)
This signal is delivered to the magnetron power supply where it passes through a normally open alarm relay contact. The alarm relay contact closes when all internal interlocks of the magnetron power supply are satisfied and the interlock signal is returned to the magnetron head at pin 4 (see above).

Pins 6 and 7 – High voltage enable relay contacts
These pins are connected to normally open contacts K1A of relay K1. Upon energizing relay K1 by pressing the “Mw Start” switch S1, contacts K1A close and deliver the high voltage enable signal to the magnetron power supply. The contacts are opened by pressing the “Mw Stop” button.

Pin 8 – Chassis ground

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Remote Control Connections

All connections for remote control of the magnetron power supply and magnetron head are made to connector J3. Figure 2 below is a diagram of a recommended electrical circuit configuration. While other configurations are possible, the following interface requirements must be met for safe and reliable operation.

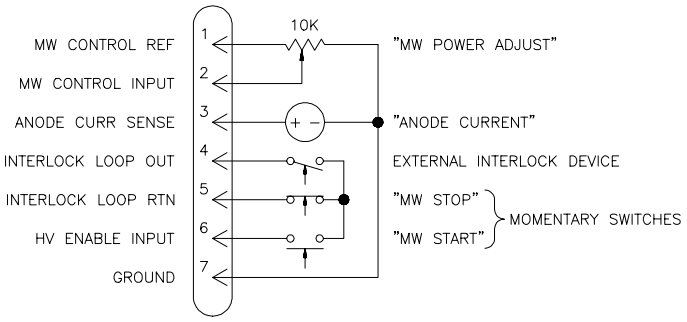

Figure 2 – Recommended electrical circuit for remote control.

Pin 1 – Microwave control voltage reference (+10 VDC)
This is a DC voltage generated by the magnetron power supply for use by a remote power control potentiometer. Because the current output of the voltage source is limited, and for maximum operational stability, this voltage should not be used for any other purpose.

Pin 2 – Microwave control voltage input (0-10 VDC)
The level of microwave power delivered from the magnetron head is controlled by varying the voltage present at this pin from 0 to 10 VDC. The use of a precision multi-turn, 10K Ohm potentiometer rated for ½ Watt is recommended for high control resolution and stability. The voltage provided at pin 1 (see above) may be used as a reference, or a separate voltage source referenced to the same ground point can also be used. The toggle switch on the front panel of the magnetron head must be set to “Remote” for this voltage to have effect.

Pin 3 – Anode current sense output (1 V = 100 mA)
This signal is generated by the magnetron power supply and is proportional to the magnetron anode current. It is proportional to magnetron output power and thus can used as an indication of microwave power generated by the magnetron head. The recommended minimum load impedance for voltage measuring devices is 250 Ohms.

Pin 4 – Interlock loop output (24 VAC)
This signal is present when all internal interlocks of the magnetron power supply are satisfied and the “Mw Stop” switch on the front panel of the magnetron head is not being

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pressed. This signal must be present for operation of the magnetron head and microwave power generation.

Pin 5 – Interlock loop return (24 VAC)
The voltage present at pin 4 must be returned through pin 5 before microwave power can be started. A dry contact interlock device and/or remote “Mw Stop” switch (momentary, normally closed) may be connected in series between pins 4 and 5. Opening either of these two devices will cause microwave power generation to cease.

Pin 6 – High voltage enable input (24 VAC)
Connecting the voltage at pin 4 to pin 6 will cause the magnetron power supply to deliver high voltage to the magnetron head. Microwave power will then be generated according to the setting of the microwave power control potentiometer(s). The recommended device for making this connection is a momentary, normally open pushbutton switch.

WARNING: *Serious injury and/or death can result from the use of a non-momentary switching device for enabling high voltage and microwave power. The use of a latching device can allow high voltage to be enabled inadvertently and unknowingly, such as can happen upon resetting an interlock device. It is strongly recommended that a momentary switching device be used for the high voltage enable function.*

Pin 7 – Chassis ground

Chassis Ground Connection

The chassis of GA4002 magnetron head must be connected directly to the chassis of the magnetron power supply. Connection to the magnetron head chassis is at the ground stud located at the side near the electrical connectors. Connection to the power supply chassis is at the ground stud located at the rear of the chassis. The recommended wire is 14 AWG, UL 1007 (or equivalent) with green or green/yellow insulation.

WARNING: *Failure to provide an adequate ground connection between the magnetron head and power supply chassis can expose the operator to high voltage and result in severe injury or death.*

OPERATION

Basic Operation

All interlocks must be satisfied before operation of the microwave generator can begin. This “standby” condition is indicated by the absence of any lighted indicator lights on the front panel of the magnetron power supply.

Pressing the “Start” button on the front panel of the magnetron head will enable magnetron power supply and deliver high voltage to the magnetron. However, The actual level of microwave power output will be determined by the setting of the microwave power control as explained below.

Pressing the “Stop” button on the magnetron head, or opening any of the interlocks, will stop the generation of microwave power.

Microwave Power Control

The level of microwave power generated is determined by the settings of the power control potentiometers or remote analog input signal. Control potentiometers are located on the front panels of both the magnetron power supply and magnetron head.

A toggle switch located on the front panel of the magnetron head selects between “Mag Head” (up position), “Power Supply” (center position) and “Remote Analog” (down position) for the location of power control. When “Power Supply” is selected the magnetron head potentiometer and remote analog signal are both disabled.

The power control potentiometer on the magnetron power supply is the primary control and will override the settings of the other power controls *unless set to zero*. For example, if the magnetron head potentiometer is set to 50% power and the magnetron power supply potentiometer is set to zero then microwave output power will be 50%. If the magnetron power supply potentiometer is then adjusted to 75% then the microwave output power will be 75%. The same interaction occurs between the magnetron power supply potentiometer and the remote analog control signal.

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MAINTENANCE AND CALIBRATION

The GA4002 magnetron head is designed to be maintenance free with the exception of magnetron replacement. The magnetron is considered a consumable component and has a life expectancy of 1000 to 3000 hours depending on operating conditions and usage. No calibration is necessary.

Although the GA4002 magnetron head is a very rugged and stable device, it can be subject to damage due to improper operating conditions or mishandling. If damage occurs, the magnetron head should be returned to GAE for repair. Contact GAE for information on repair services.

Magnetron Removal and Replacement

The magnetron can be replaced by the user as follows:

1. Turn off the magnetron power supply and disconnect all electrical connections from the magnetron head.
2. Disconnect the source of cooling water, both supply and drain.
3. Turn the four captive cover screws ¼ turn and remove the cover.
4. Remove the brown filament lead insulator block and disconnect the filament transformer and high voltage leads from the magnetron.
5. Loosen the hose clamps and remove the two hoses from the magnetron water fittings.
6. Remove the four nuts (below the magnetron) securing the magnetron to the chassis and carefully lift out the magnetron.
7. Disconnect the two leads connected to the thermal switch mounted to the side of the magnetron.
8. Connect the two thermal switch leads onto the thermal switch mounted to the new magnetron.
9. Install the new magnetron in the reverse order of removal.
10. Connect the cooling water supply and check for water leaks.
11. Replace the chassis cover.

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